TES Cloud Comparisons: MODIS

A. Eldering and the TES team
Jet Propulsion Laboratory/Caltech
October 2007

Outline

- TES approach to clouds
- Statistics compared with MODIS
- Comments on improvements in v003
- Conclusions

COMPARISON TO FORMER APPROACHES

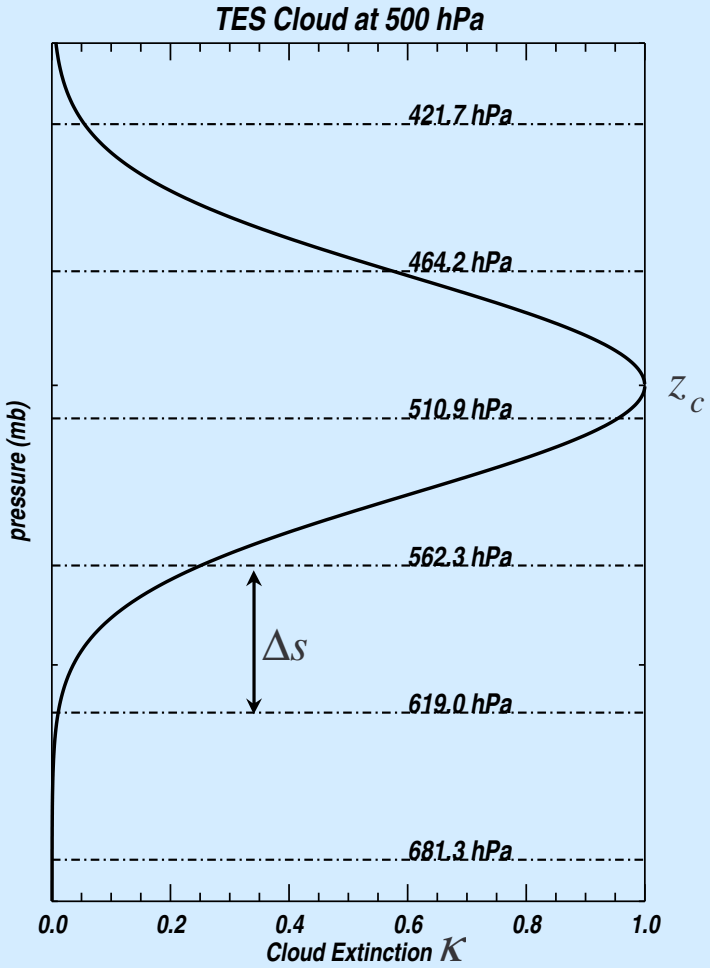
Other instruments retrieve atmospheric parameters with clouds.

AIRS, TOMS, OMI, MOPITT successfully retrieve in the presence of clouds

TES's approach is somewhat different than prior approaches

1) Parameterize clouds and place the effect of these parameters into our forward model
2) Retrieve cloud parameters like any other retrieved parameter, with an initial guess, *a priori*, constraint, and Jacobians
3) Error characterization *and effect of clouds on retrieved atmospheric species* is handled like any other retrieved parameter

TES CLOUD PARAMETERIZATION



- **Single cloud layer modeled as a Gaussian profile**
- **Absorption and scattering modeled with an effective tau discretized on a coarse frequency grid 25 – 100 cm^{-1}**

$$\tau_{\nu,z} = \kappa_\nu e^{-\beta(z-z_c)^2} \Delta s$$

Altitude

Effective extinction (25 frequency values)

width parameter (fixed)

layer thickness

Initial guess: cloud pressure = 500 mb. Cloud extinction by Brightness temperatures between observed radiance and TES cloud-free initial guess

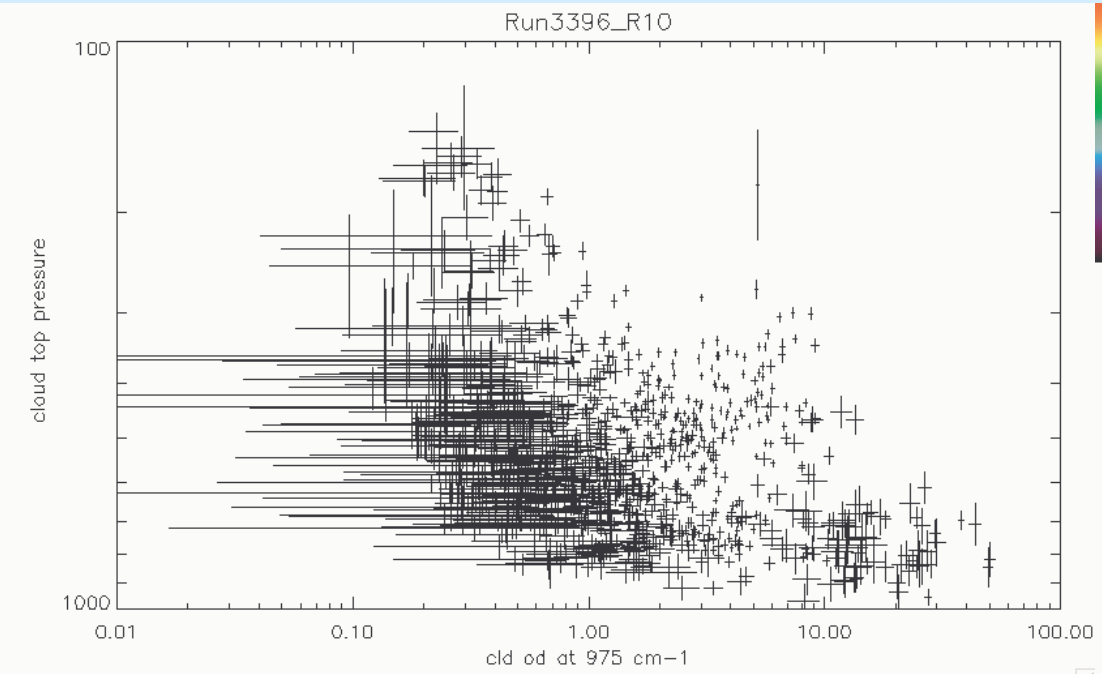
The data sets

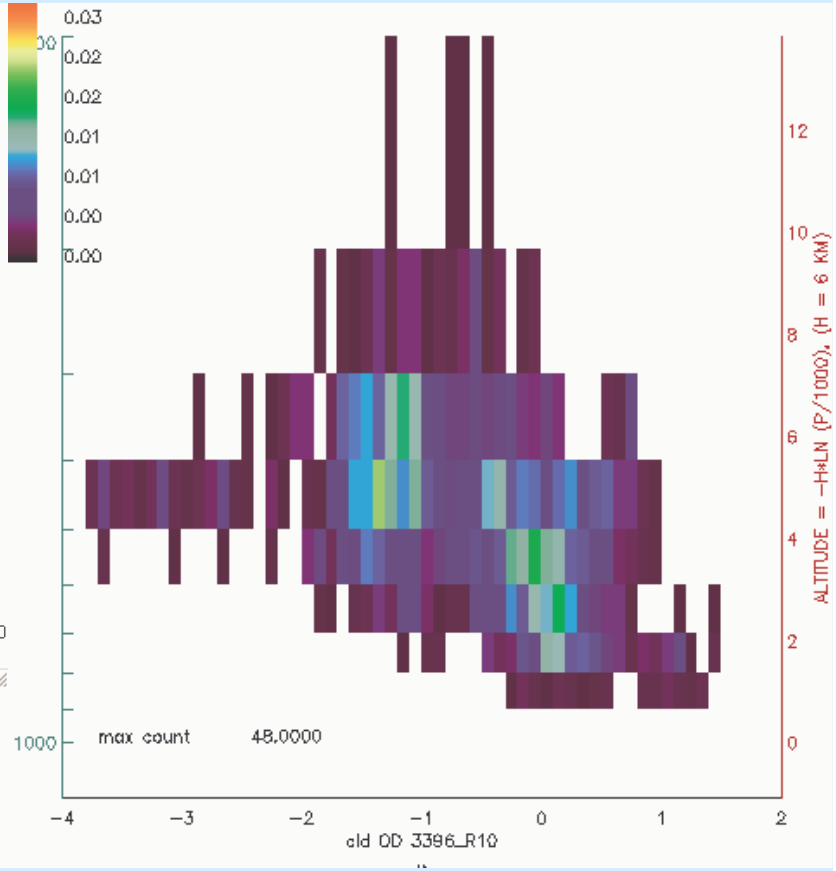
- TES
  - Step and stares as well as global surveys
  - Data averaged over 16 pixels to 5km by 8km
  - Some screening based on ctp error (< 100mb) and effective optical depth (error < 2*od) in later analysis
- MODIS data
  - Cloud top pressure - 5km product day and night
  - Cloud optical depth - 1km product, daytime only
  - Only use confidently cloudy data (cloud mask = 0)

Analysis approach

- Scattergrams and statistics on optical depth and cloud top pressure
- Interpretation in context of cloud homogeneity and error estimates

TES characteristics

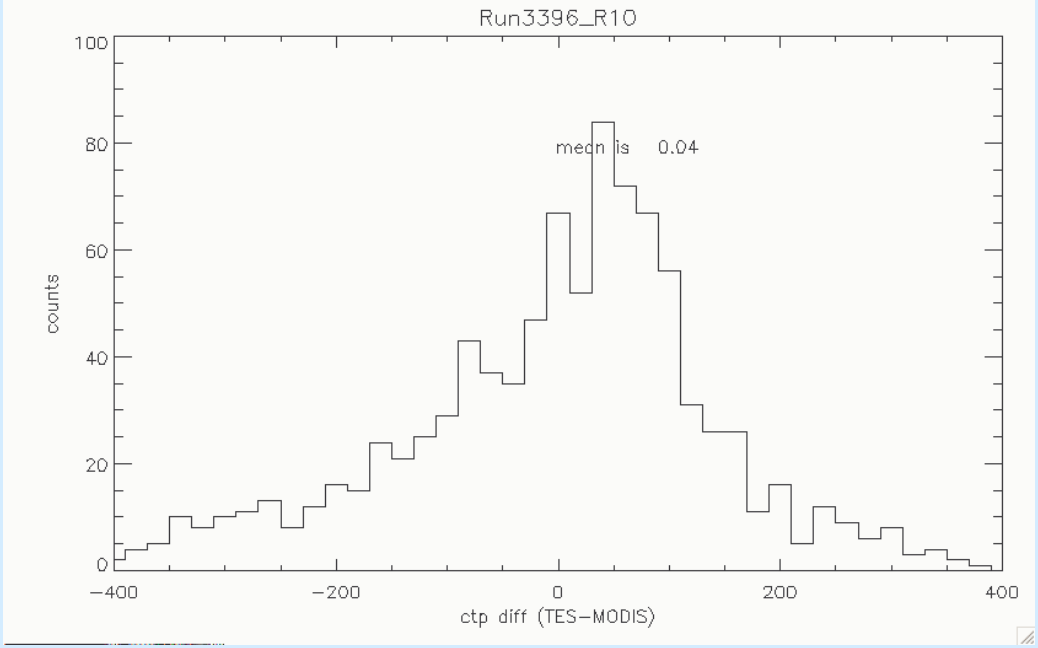




- Low optical depth data have larger errors
- Thick near surface clouds uncertain

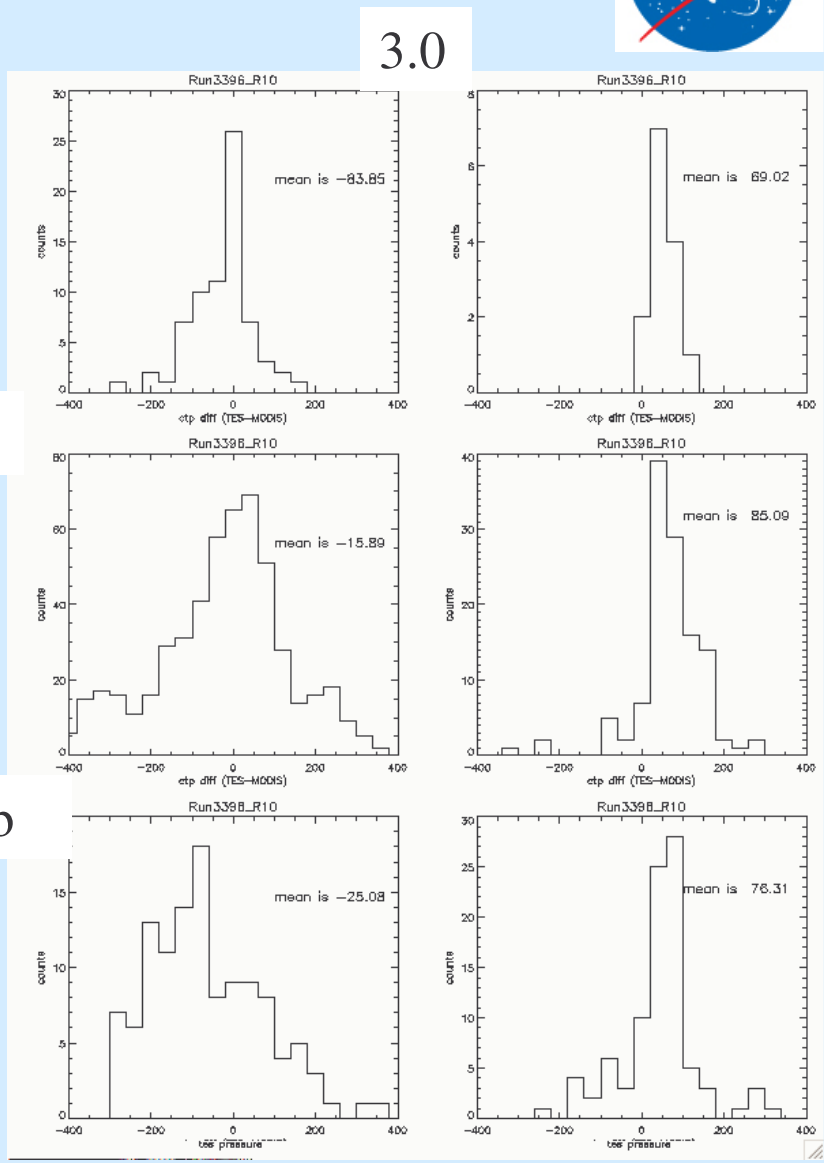
Cloud Top Pressure

- Histogram of TES-MODIS
- Majority of TES CTP are within -100 to +100 mb of MODIS. TES bias to larger pressures in part due to Gaussian cloud.



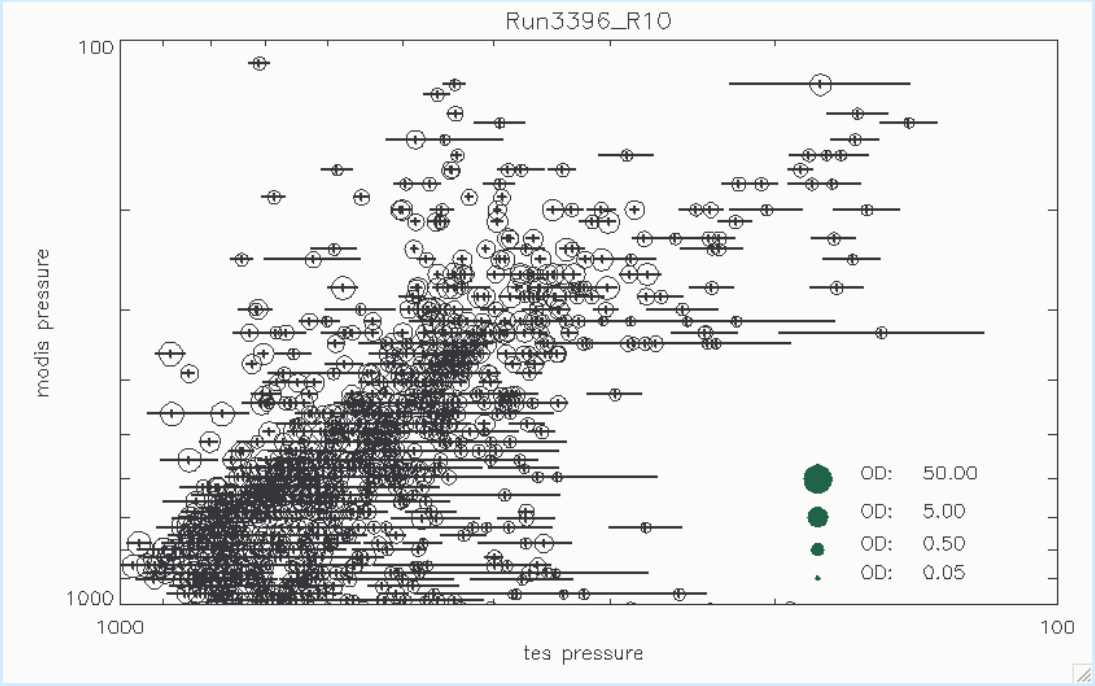
Details of CTP

- Six groups of data
- Low and middle clouds with lower OD have outliers
- Thicker clouds consistently show TES CTP> MODIS by 100mb

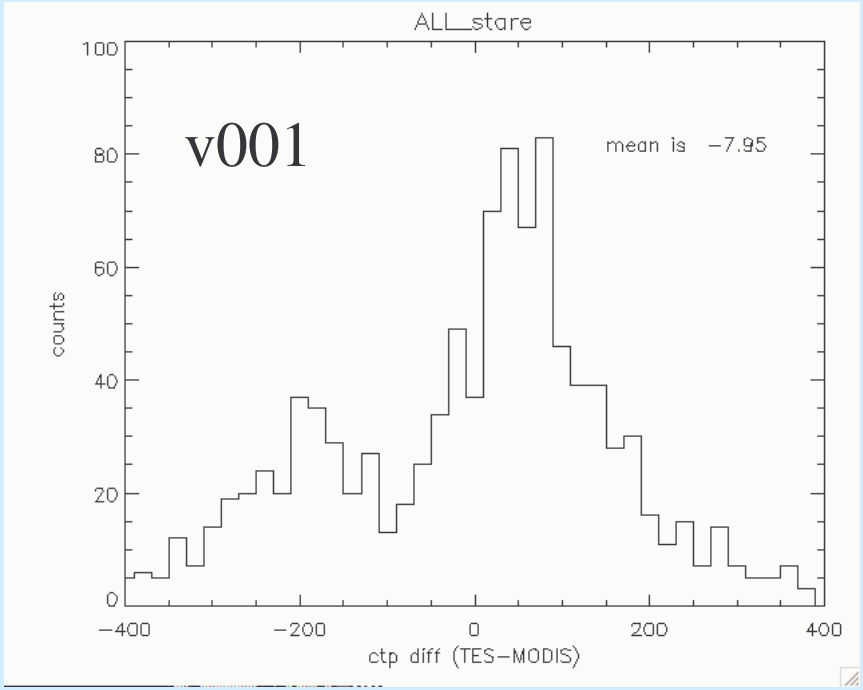


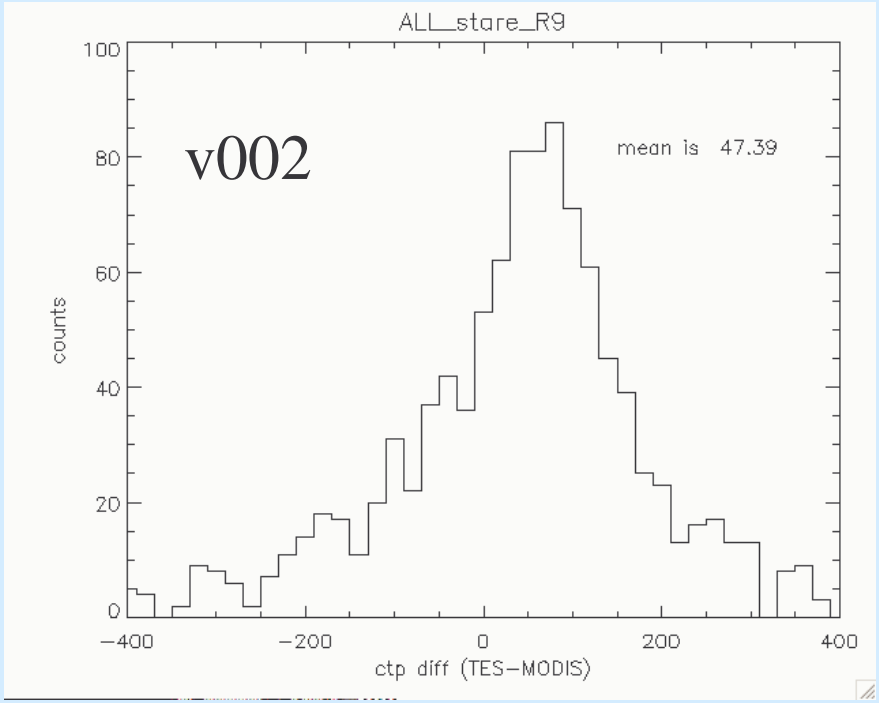
Optical depth comparison

- MODIS and TES see fundamentally different optical depth
- Expect ~2 scaling, depending on cloud type



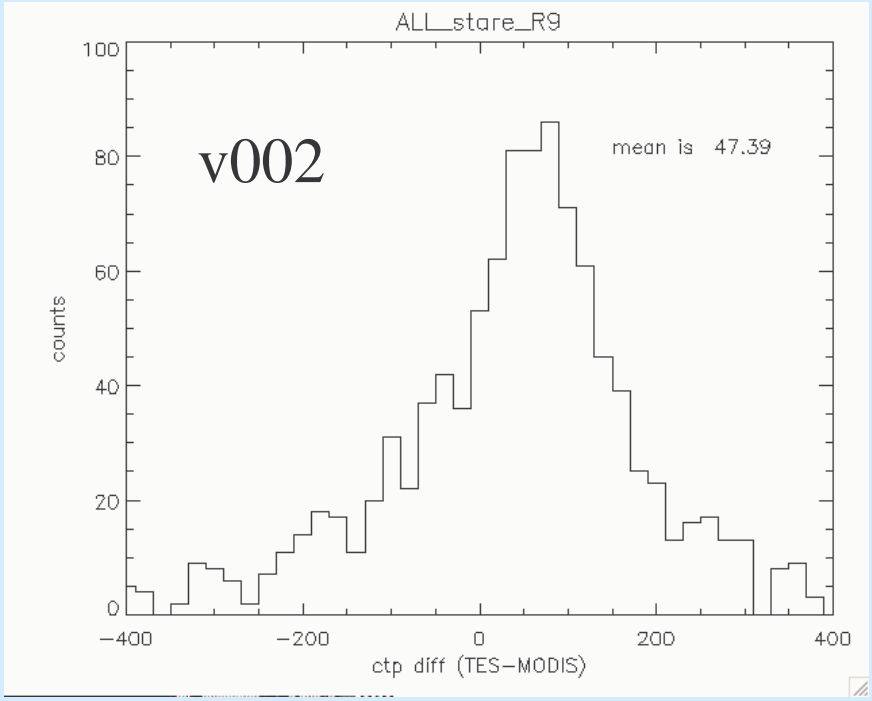
Improvement of v002

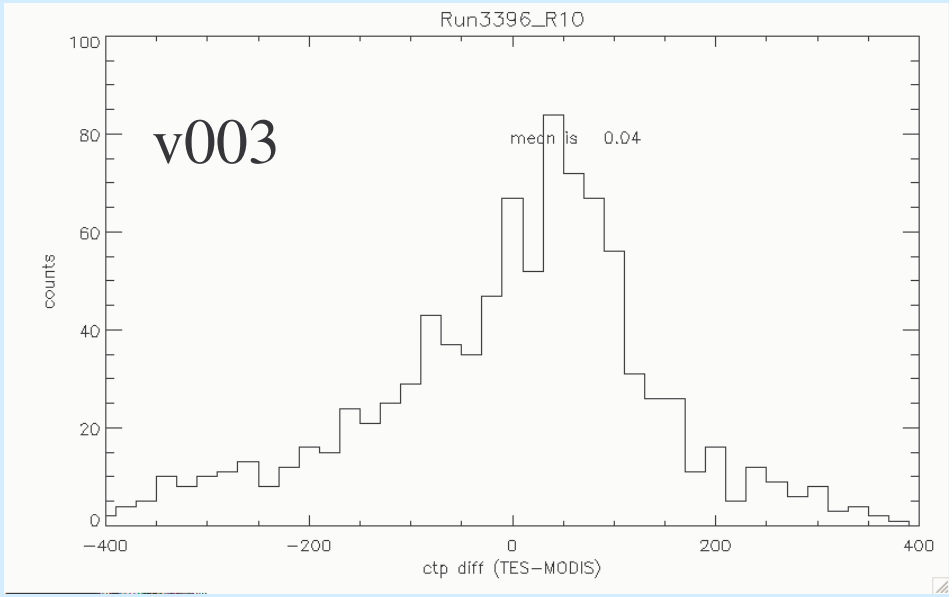




- No longer have tail of -200 mb differences

Improvement of v003

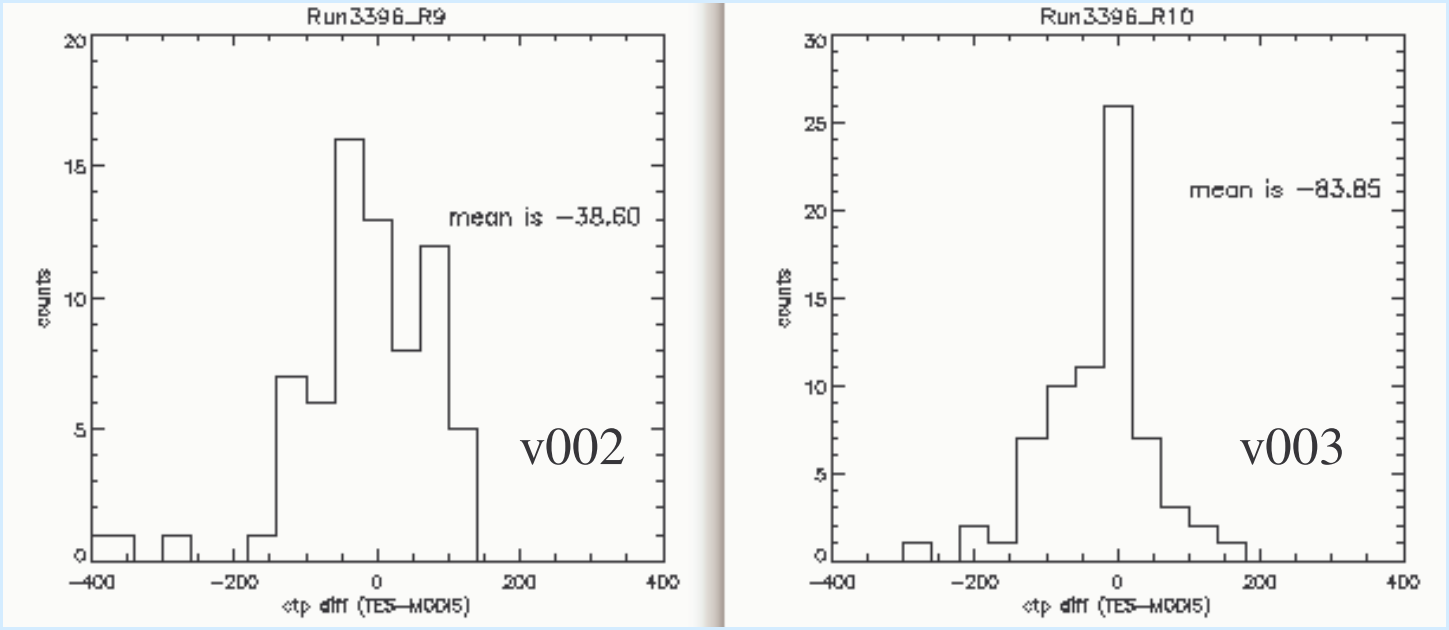




- Integrates statistics between v002 and v003 show very little difference

High cloud changes

(optical depth less than 3 and cloud top pressure less than 350 mb)



- Changes to initial guess results in better agreement of cloud top pressure for thin clouds


NASA


tes

What's ahead?

- Improved initial guess - will place more clouds at very low optical depths
- Limb detection used in R10

Limb detection

Limb Approach

- Forward model calc to predict radiance in window region (use integrated BT10)
- Label pixel as cloudy if measured - model greater than threshold
- Also discard one pixel above cloudy one
- Conservative thresholds developed empirically with AIRS clouds, visible imagery, and set of a few hundred footprints.